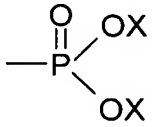
CLAIMS

1. Dendritic polymers of generation n composed of:

- a central core of valence m;
- optionally generation chains branching around the core;
- an intermediate chain at the end of each bond around the core or at the end of each generation chain, where appropriate; and
- a terminal group at the end of each intermediate chain,

wherein m represents an integer from 3 to 8; n represents an integer from 0 to 12, characterised in that the terminal group is composed of the group of formula:



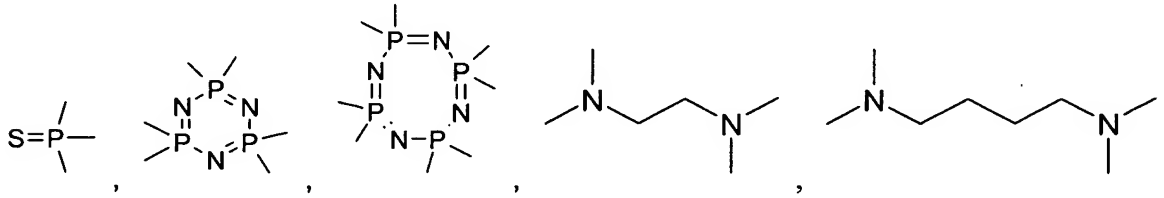
wherein each of the radicals X, which may be identical or different, represents a radical –Me, -H and/or $-M^+$, wherein M^+ is a cation,

with the exception of the compound of formula:

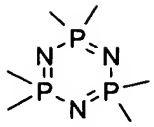
$CH_3\text{-}CH_2\text{-}C[CH_2O\text{-}C(OSiMe_3)=CH\text{-}CH_2\text{-}P(=O)\text{-}(OH)_2]_3$.

2. Dendritic polymers according to claim 1, wherein the central core contains at least one phosphorus atom.

3. Dendritic polymers according to claim 1 or 2, wherein the central core is selected from the following groups:



4. Dendritic polymers according to any one of the preceding claims, wherein the central core has the formula:



5. Dendritic polymers according to any one of the preceding claims having a DAB-AM, PAMAM, PMMH structure.

6. Dendritic polymers according to any one of the preceding claims, wherein M^+ represents the cation of an element of group IA, IIA, IIB or IIIA of the periodic table or M^+ represents $HNEt_3^+$.

7. Dendritic polymers according to any one of the preceding claims, wherein M is selected from sodium and potassium atoms.

8. Dendritic polymers according to any one of the preceding claims, wherein n is from 0 to 3.

9. Dendritic polymers according to any one of the preceding claims, wherein m is selected from 3, 4 and 6.

10. Dendritic polymers according to any one of the preceding claims, wherein the generation chains are selected from any linear or branched hydrocarbon chain having from 1 to 12 chain members and optionally containing one or more double or triple bonds, it being possible for each of said chain members optionally to be selected from a heteroatom, a group Aryl, Heteroaryl, >C=O, >C=NR, it being possible for each chain member to be optionally substituted by one or more substituents selected from -Alkyl, -Hal, $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -OAlkyl, -Aryl, -Aralkyl,

wherein

R and R', which may be identical or different, each independently of the other represents a hydrogen atom or a radical -Alkyl, -Aryl, -Aralkyl.

11. Dendritic polymers according to any one of the preceding claims, wherein the generation chains, which may be identical or different, are represented by formula:

-A-B-C(D)=N-N(E)-(P(=G))< (C1)

wherein:

A represents an oxygen, sulfur or phosphorus atom or a radical -NR-;

B represents a radical -Aryl-, -Heteroaryl-, -Alkyl-, each of which may optionally be substituted by a Halogen atom or by a radical $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl;

C represents a carbon atom,

D and E, which may be identical or different, each independently of the other represents a hydrogen atom, a radical -Alkyl, -OAlkyl, -Aryl, -Aralkyl, each of which may optionally be substituted by a Halogen atom or by a radical $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl;

G represents a sulfur, oxygen, selenium or tellurium atom or a radical =NR;

R and R', which may be identical or different, each independently of the other represents a hydrogen atom or a radical –Alkyl, -Aryl, -Aralkyl;

< represents the two bonds at the end of each generation chain.

12. Dendritic polymers according to claim 11, wherein A represents an oxygen atom.

13. Dendritic polymers according to claim 11 or 12, wherein B represents a phenyl ring optionally substituted by a halogen atom or by a radical $–NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl.

14. Dendritic polymers according to any one of claims 11 to 13, wherein B represents an unsubstituted phenyl ring.

15. Dendritic polymers according to any one of claims 11 to 14, wherein D represents a hydrogen atom.

16. Dendritic polymers according to any one of claims 11 to 15, wherein E represents a radical –Alkyl.

17. Dendritic polymers according to any one of claims 11 to 16, wherein G represents a sulfur atom.

18. Dendritic polymers according to any one of claims 1 to 10, wherein the generation chains are represented by formula:

-A'-(C=O)-N(R)-B'-N< (C1')

wherein

A' and B' each independently of the other represents a radical -Alkyl, -Alkenyl, -Alkynyl, by one or more substituents selected from -Alkyl, -Hal, $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -OAlkyl, -Aryl, -Aralkyl;

R, R' have the meaning defined hereinbefore.

19. Dendritic polymers according to any one of claims 1 to 10, wherein the generation chains are represented by formula:

-A''-N< (C1'')

wherein

A'' represents a radical -Alkyl, -Alkenyl, -Alkynyl, by one or more substituents selected from -Alkyl, -Hal, $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -OAlkyl, -Aryl, -Aralkyl, wherein RR' have the meaning defined hereinbefore.

20. Dendritic polymers according to any one of the preceding claims, wherein the generation chains are identical.

21. Dendritic polymers according to any one of the preceding claims, wherein the intermediate chains, which may be identical or different, are represented by formula:

-J-K-L- (C2)

wherein

J represents an oxygen atom, a sulfur atom or a radical -NR-;

K represents a radical -Aryl-, -Heteroaryl-, -Alkyl-, each of which may optionally be substituted by a Halogen atom or by a radical $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl;

L represents a hydrocarbon chain having from 1 to 6 chain members and optionally containing one or more heteroatoms and/or optionally containing one or more double or triple bonds, it being possible for each of said chain members to be optionally substituted by one or more substituents selected from -OH, -NRR', -OAlkyl;

R and R', which may be identical or different, each independently of the other represents a hydrogen atom or a radical –Alkyl, -Aryl, -Aralkyl.

22. Dendritic polymers according to any one of claims 11 to 21, wherein J and K are equal to A and B, respectively.

23. Dendritic polymers according to claim 21, wherein J represents an oxygen atom.

24. Dendritic polymers according to claim 21 or 23, wherein K represents a phenyl ring optionally substituted by a Halogen atom or by a radical $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl, -Alkyl, -Hal, $-NO_2$, -CN, $-CF_3$, -Aryl, -Aralkyl.

25. Dendritic polymers according to any one of claims 21, 23, 24, wherein K represents an unsubstituted phenyl ring.

26. Dendritic polymers according to any one of claims 21, 23 to 25, wherein L represents a radical –Alkyl-, -Alkenyl- or –Alkynyl-, each of which may optionally be substituted by one or more substituents selected from –OH, -NRR', -OAlkyl.

27. Dendritic polymers according to any one of claims 21, 23 to 26, wherein L represents a radical –Alkenyl- or a radical –Alkyl-, optionally substituted by a radical –OH .

28. Dendritic polymers according to any one of claims 21, 23 to 27, wherein L represents a radical –Alkyl- optionally substituted by a radical –OH.

29. Dendritic polymers according to any one of claims 1 to 20, wherein the intermediate chains are represented by formula (C2') :

-L''- (C2')

wherein L'' represents an –Alkyl- chain having from 1 to 6 chain members, optionally substituted by one or more substituents selected from –OH, -NRR', -OAlkyl.

30. Dendritic polymers according to any one of the preceding claims which are represented by formula (I):

$$\S\text{-}\{\{A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G))<\}^{n}\text{-}[J\text{-}K\text{-}L\text{-}PO_3X_2]_2\}_m \quad (I)$$

in which:

§, A, B, C, D, E, G, N, P, J, K, L, X, m, n, < have the meaning defined according to the preceding claims.

31. Dendritic polymers according to any one of claims 1 to 29 which are represented by the following formula (I-2):

$$\S\text{-}\{\{A'\text{-}(C=O)\text{-}N(R)\text{-}B'\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3X_2]\}_m \quad (I\text{-}2)$$

in which:

§, A', B', C, N, P, X, L'', m, n have the meaning defined hereinbefore.

32. Dendritic polymers according to any one of claims 1 to 29 which are represented by the following formula (I-3):

$$\S\text{-}\{\{A''\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3X_2]\}_m \quad (I\text{-}3)$$

in which:

§, A'', N, P, X, L'', m, n have the meaning defined hereinbefore.

33. Method for preparing a dendritic polymer according to any one of the preceding claims, comprising:

(i) reacting the corresponding dendritic polymer having a terminal function -CHO, -CH=NR or $(P(=S)Cl_2$

with

a compound of formula Z-PO_3Me_2, wherein Z represents:

- either -H when the function is –CHO or -CH=NR,
- or the intermediate chain defined hereinbefore when said function represents -(P(=S)Cl_2 ;

(ii) optionally followed, when X represents H or M, by a step which comprises converting the dendritic polymer obtained in (i) having a -PO_3Me_2 termination into the corresponding dendritic polymer having a -PO_3H_2 termination;

(iii) optionally followed, when X represents M, by a step which comprises converting the dendritic polymer obtained in (ii) having a -PO_3H_2 termination into the salt of the corresponding dendritic polymer having a -PO_3M_2 termination.

34. Method for preparing dendritic polymers according to any one of claims 28 to 30 of formula (I)

$$§\text{-}\{\{A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G))<\}^n[J\text{-}K\text{-}L\text{-}PO_3X_2]_2\}_m \quad (I)$$

in which:

§, A, B, C, D, E, G, N, P, J, K, L, X, m, n, < have the meaning defined in any one of the preceding claims, characterised in that said method comprises:

(i) a step which comprises treating the corresponding dendritic polymer of formula

$$§\text{-}\{\{A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G))<\}^nY_2\}_m \quad (II\text{-}1)$$

wherein Y represents:

- either -J-K-L', wherein L' represents a radical –CHO or -CH=NR;
- or –Cl;

with a compound of formula Z-PO_3Me_2, wherein Z represents:

- either H- when Y represents -J-K-L';
- or H-J-K-L- when Y represents Cl;

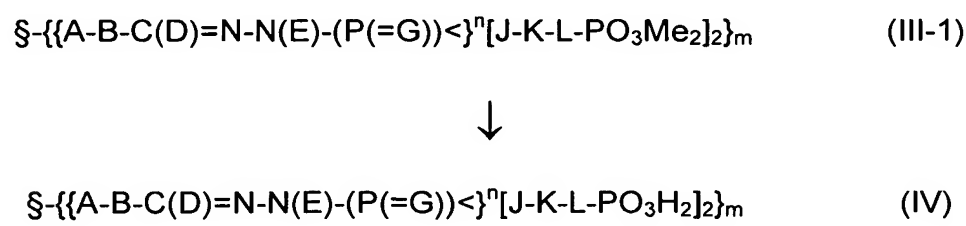
in order to obtain a dendritic polymer of formula (III-1):

$$§\text{-}\{\{A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G))<\}^n[J\text{-}K\text{-}L\text{-}PO_3Me_2]_2\}_m \quad (III\text{-}1)$$

in which:

§, A, B, C, D, E, G, N, P, J, K, L, R, m, n, < have the meaning defined hereinbefore,

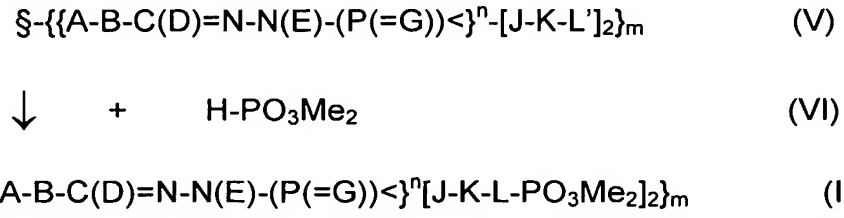
(ii) optionally followed, when X represents H or M, by a step which comprises converting the dendritic polymer of formula (III-1) obtained in (i) into the corresponding dendritic polymer of formula (I) in which X represents a hydrogen atom, according to the following reaction scheme:



in which §, A, B, C, D, E, G, N, P, J, K, L, n, m, < have the meaning defined hereinbefore,

(iii) optionally followed, when X represents M, by a step which comprises converting the dendritic polymer of formula (IV) obtained in (ii) into the corresponding salt of formula (I) wherein M represents a metal atom.

35. Method according to claim 34, according to which step (i) comprises the following reaction:



wherein §, A, B, C, D, E, G, N, P, J, K, L, L', m, n, < have the meaning defined hereinbefore,

wherein said reaction is carried out in the presence of an organic or inorganic base, at a temperature of from -80°C to 100°C.

36. Method according to claim 35, wherein the base is triethylamine.

37. Method according to claim 34, according to which step (i) comprises the following reaction:

$$\S\text{-}\{\{A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G))<\}^n(Cl_2)\}_m \qquad (VII)$$

$$\downarrow \quad + \quad H\text{-}J\text{-}K\text{-}L\text{-}PO_3Me_2 \qquad (VIII)$$

$$\S\text{-}\{,A\text{-}B\text{-}C(D)=N\text{-}N(E)\text{-}(P(=G)\ )<\}^n[J\text{-}K\text{-}L\text{-}PO_3Me_2]_2\}_m \qquad (III\text{-}1)$$

wherein

§, A, B, C, D, E, G, N, P, J, K, L, m, n have the meaning defined hereinbefore,

wherein said reaction is carried out in solution in a polar aprotic solvent, in the presence of an organic or inorganic base, at a temperature of from -80°C to 100°C.

38. Method according to claim 37, wherein the base is cesium carbonate.

39. Method for preparing a dendritic polymer according to either claim 31 or claim 32 of formula (I-2)

$$\S\text{-}\{\{A'\text{-}(C=O)\text{-}N(R)\text{-}B'\text{-}NH\text{-}\}^n[L''\text{-}PO_3X_2]\}_m (I\text{-}2)$$

or of the following formula (I-3):

$$\S\text{-}\{\{A''\text{-}NH\text{-}\}^n[L''\text{-}PO_3X_2]_2\}_m \ (I\text{-}3)$$

in which §, A', B', C, A'', N, P, X, L'', m, n have the meaning defined hereinbefore, comprising

step (i), which comprises reacting the corresponding dendritic polymer n of formula

$$\S\text{-}\{\{A'\text{-}(C=O)\text{-}N(R)\text{-}B'\text{-}N=R\}^n\}_m \qquad (II\text{-}2)$$

$$\text{or } \S\text{-}\{\{A''\text{-}N=R\}^n\}_m \qquad (I\text{-}3)$$

wherein R is a radical >Alkyl,

with a compound of formula $H\text{-}PO_3Me_2$ (VI),

(ii) optionally followed, when X represents H or M, by a step which comprises converting the dendritic polymer of formula (III-2) or (III-3) obtained in (i) in which X represents a Methyl radical into the corresponding dendritic polymer of

formula (I-2) or (I-3) in which X represents a hydrogen atom, according to the following reaction scheme:

$$\S\text{-}\{\{A'\text{-}(C{=}O)\text{-}N(R)\text{-}B'\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3Me_2]\}_m \quad \text{(III-2)}$$

$$\text{or } \S\text{-}\{\{A''\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3Me_2]\}_m \quad \text{(IIII-3)}$$

↓

$$\S\text{-}\{\{A'\text{-}(C{=}O)\text{-}N(R)\text{-}B'\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3H_2]\}_m \text{(IV-2)}$$

$$\text{or } \S\text{-}\{\{A''\text{-}NH\text{-}\}^{n}[L''\text{-}PO_3H_2]\}_m \quad \text{(IV-3)}$$

(iii) optionally followed, when X represents M, by a step which comprises converting the dendritic polymer of formula (IV-2) or (IV-3) obtained in (ii) into the corresponding salt.

40. Method according to claim 39, wherein step (i) is carried out in the presence of an organic or inorganic base, at a temperature of from -80°C to 100°C.

41. Method according to any one of claims 33 to 40, according to which reaction (ii) is carried out:

- by the action of a trimethylsilane halide, in a polar aprotic organic solvent,
- followed by the action of anhydrous MeOH, which is added to the reaction mixture.

42. Method according to claim 41, wherein the trimethylsilane halide is Me_3SiBr.

43. Method according to any one of claims 33 to 42, wherein step (iii) comprises a reaction in which the compounds of formula (IV) are made to act in the presence of a base.

44. Method according to claim 43, according to which the base is selected from sodium or potassium hydroxide.

45. Compounds of formula (VIII):

$$Z\text{-}J\text{-}K\text{-}L\text{-}PO_3Me_2 \qquad (VIII)$$

in which

Z represents H or a protecting group for the function –JH;

J represents an oxygen atom, a sulfur atom or a radical –NR-;

K represents a radical –Aryl-, -Heteroaryl-, -Alkyl-, each of which may be optionally substituted by a Halogen atom or by a radical $-NO_2$, -NRR', -CN, $-CF_3$, -OH, -Alkyl, -Aryl, -Aralkyl;

L represents a linear or branched hydrocarbon chain having from 1 to 6 chain members, it being possible for each of said chain members optionally to be selected from a heteroatom, and/or optionally containing one or more double or triple bonds, it being possible for each of said chain members to be optionally substituted by one or more substituents selected from –OH, -NRR', -OAlkyl, -Alkyl, -Hal, $-NO_2$, -CN, $-CF_3$, -Aryl, -Aralkyl.

46. Compounds according to claim 45, wherein J represents an oxygen atom.

47. Compounds according to claim 45 or 46, wherein K represents an optionally substituted phenyl ring.

48. Compounds according to any one of claims 45 to 47, in which K represents an unsubstituted phenyl ring.

49. Compounds according to any one of claims 45 to 48, in which L represents a radical –Alkyl- optionally substituted by a radical –OH, or L represents a radical -Alkenyl-.

50. Compounds according to any one of claims 45 to 49, in which L represents a radical –Alkyl-.

51. Method for preparing compounds of formula (VIII) according to any one of claims 45 to 50, in which Z represents a hydrogen atom, which method comprises a step comprising the following reaction:

$$Z\text{-}J\text{-}K\text{-}L\text{-}\ PO_3Me_2 \quad (VIII) \rightarrow H\text{-}J\text{-}K\text{-}L\text{-}\ PO_3Me_2\ (VIII)$$

wherein J, K, L have the meaning defined in any one of the preceding claims and Z represents a protecting group for the function –JH,

by deprotecting the protecting group Z.

52. Method according to claim 51, in which Hal represents bromine.

53. Method according to claim 51 or 52, comprising a step in which tetrabutylammonium fluoride is made to act on the corresponding compound of formula (X), when J represents an oxygen atom, Z represents the group TBDMS (tert-butyl-dimethyl-silyl radical).

54. Method for preparing compounds of formula (VIII) according to any one of claims 51 to 53, in which the compound of formula (VIII) wherein Z represents the protecting group for the function –JH is obtained by a step which comprises the following reaction:

$$Z\text{-}J\text{-}K\text{-}L\text{-}Hal\ (IX) \rightarrow Z\text{-}J\text{-}K\text{-}L\text{-}\ PO_3Me_2\ (VIII)$$

wherein J, K, L, Z have the meaning defined in any one of claims 51 to 53, wherein Hal represents a halogen atom,

by application or adaptation of Arbuzow's reaction.

55. Method according to claim 54, in which the product of formula (IX) is reacted in the presence of trimethyl phosphite of formula $P(OMe)_3$ (X), at a temperature of from -80°C to 150°C.

56. Use of the dendritic polymers according to any one of claims 1 to 32 for treating surfaces or being in contact with surfaces.

57. Use according to claim 56, wherein said surfaces are metal, silica-based or oxide-based.

58. Use according to claim 56 or 57, for which said dendritic polymers are used as an additive in a composition that is to be in contact with or to treat said surface.

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59. Use according to any one of claims 56 to 58, according to which said dendritic polymers are used as an anti-corrosive agent, a lubricating agent, a scale preventer or a flame retardant.